(No Model.) 3 Sheets—Sheet 1.

T. L. WILLSON.

ELECTRIC LOCOMOTIVE.

No. 483,822. Patented Oct. 4, 1892.

FIG. 1.

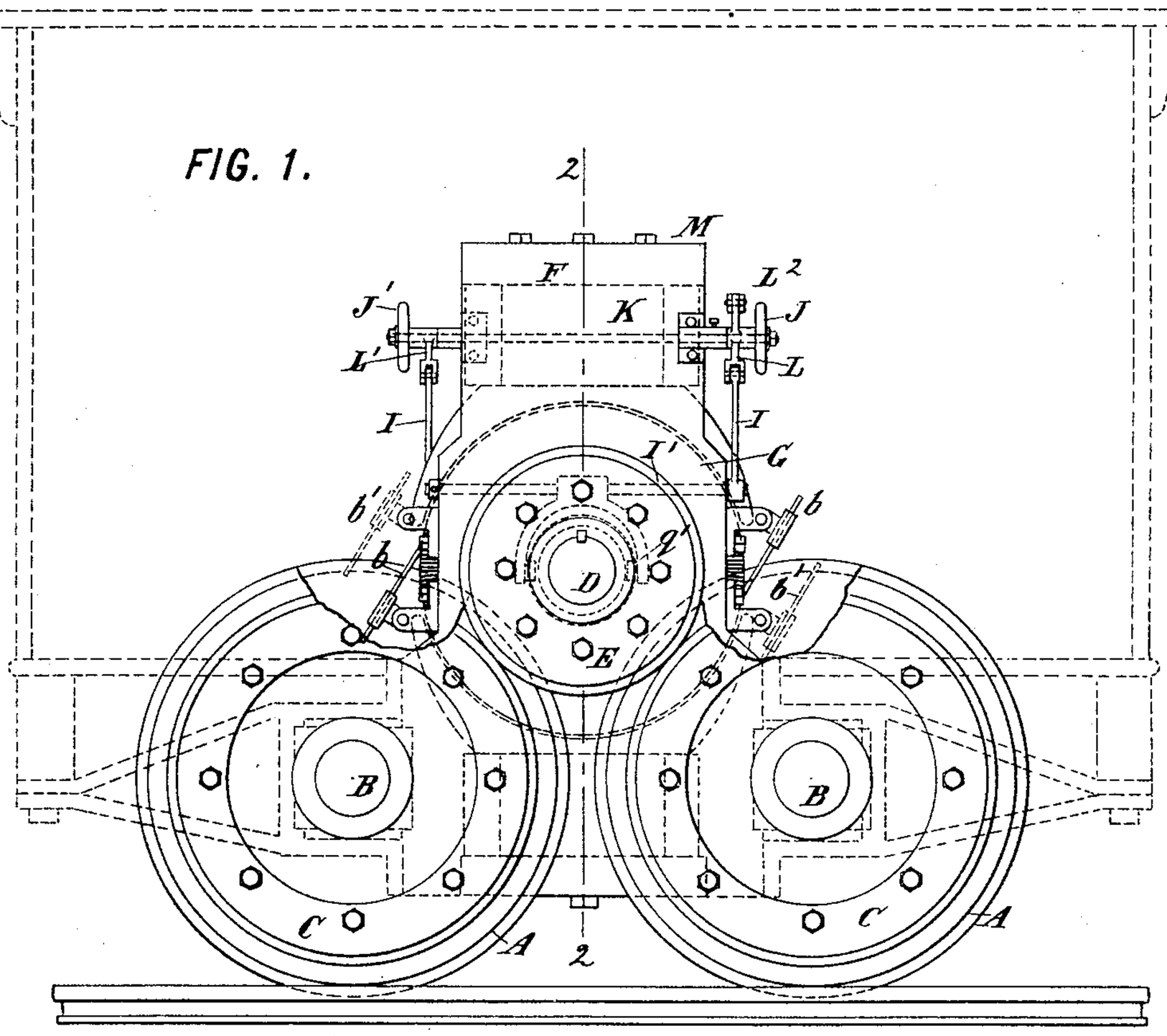
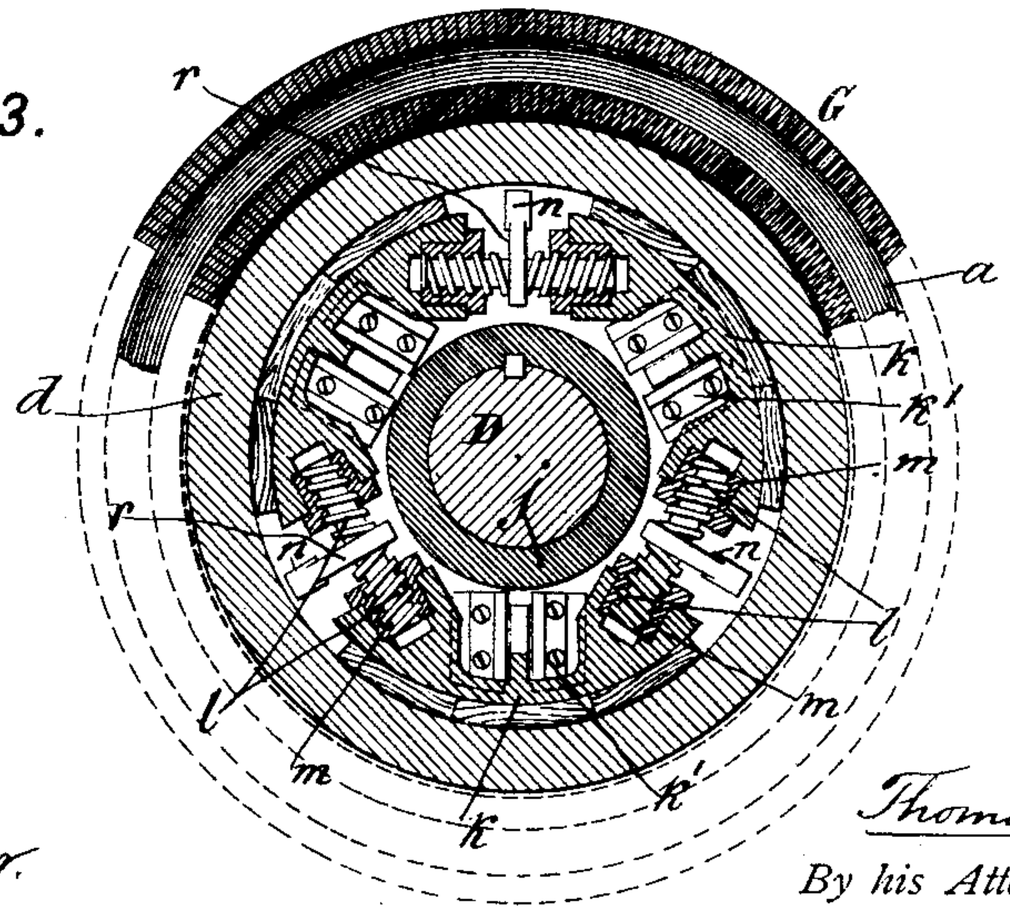


FIG. 3.



WITNESSES:
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Fred White.

INVENTOR:
Thomas L. Willson,
By his Attorneys,
Arthur G. Fraser & Co.

(No Model.)

3 Sheets—Sheet 2.

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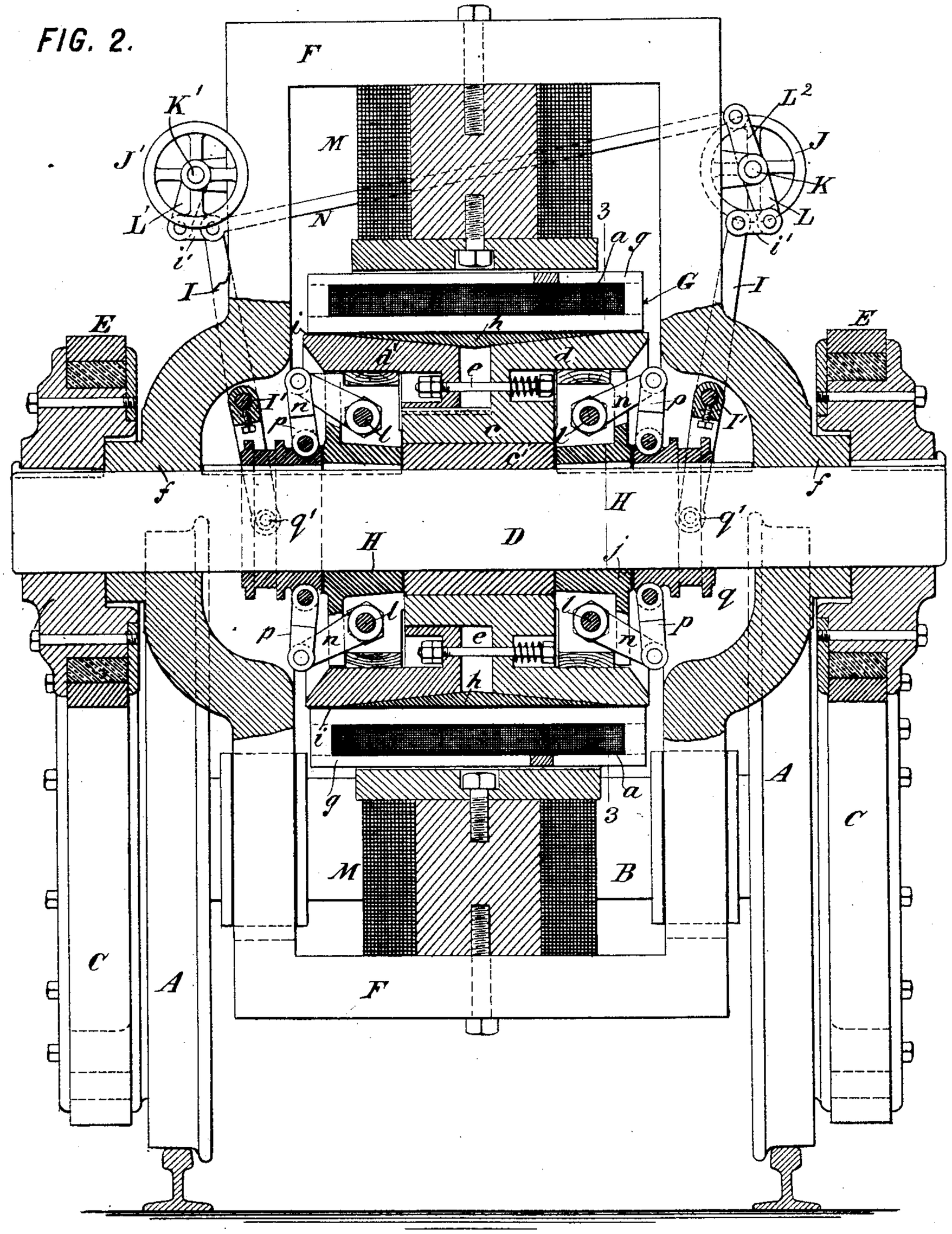
FIG. 2.



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(No Model.) 3 Sheets—Sheet 3.

T. L. WILLSON.

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FIG. 4.

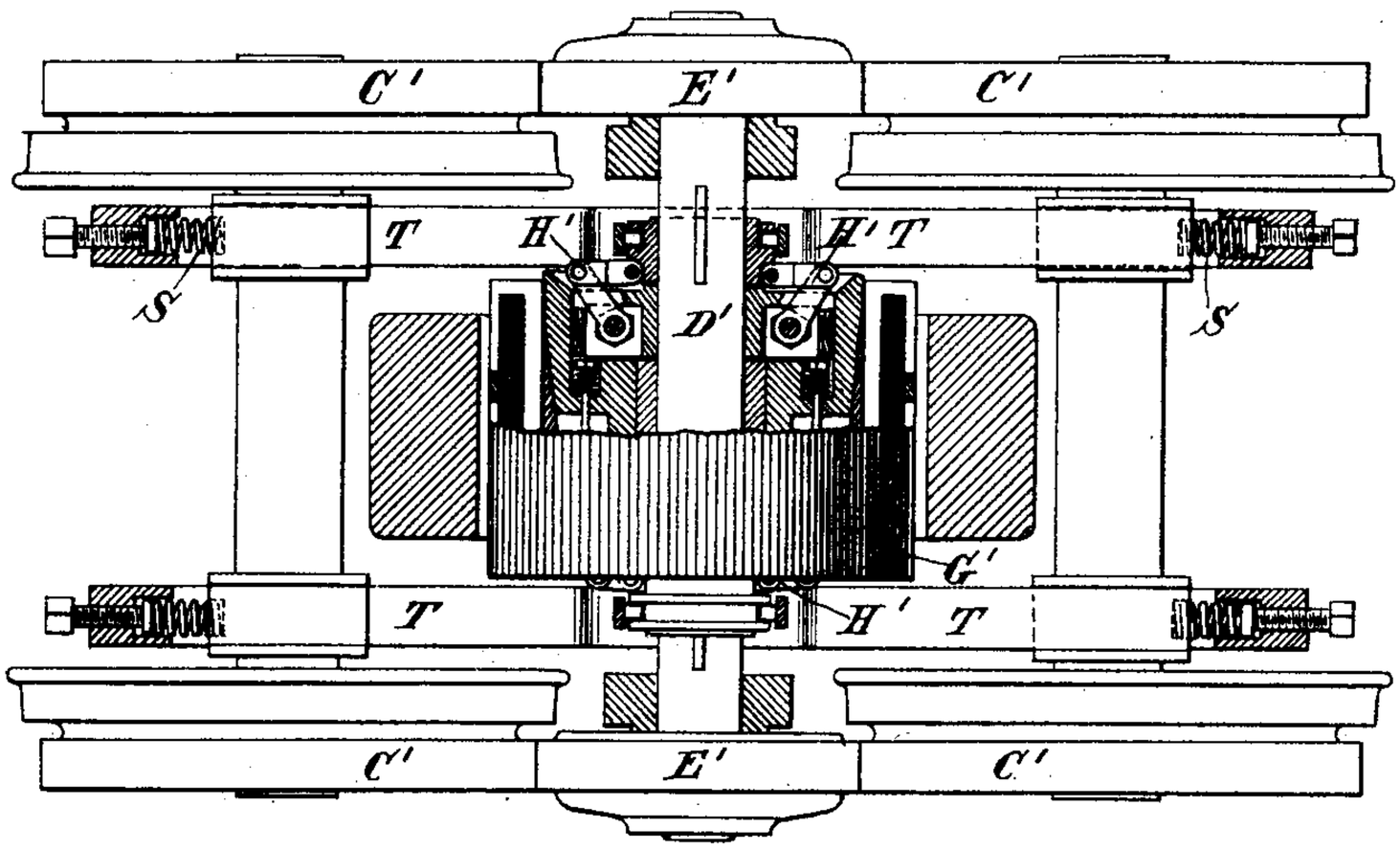
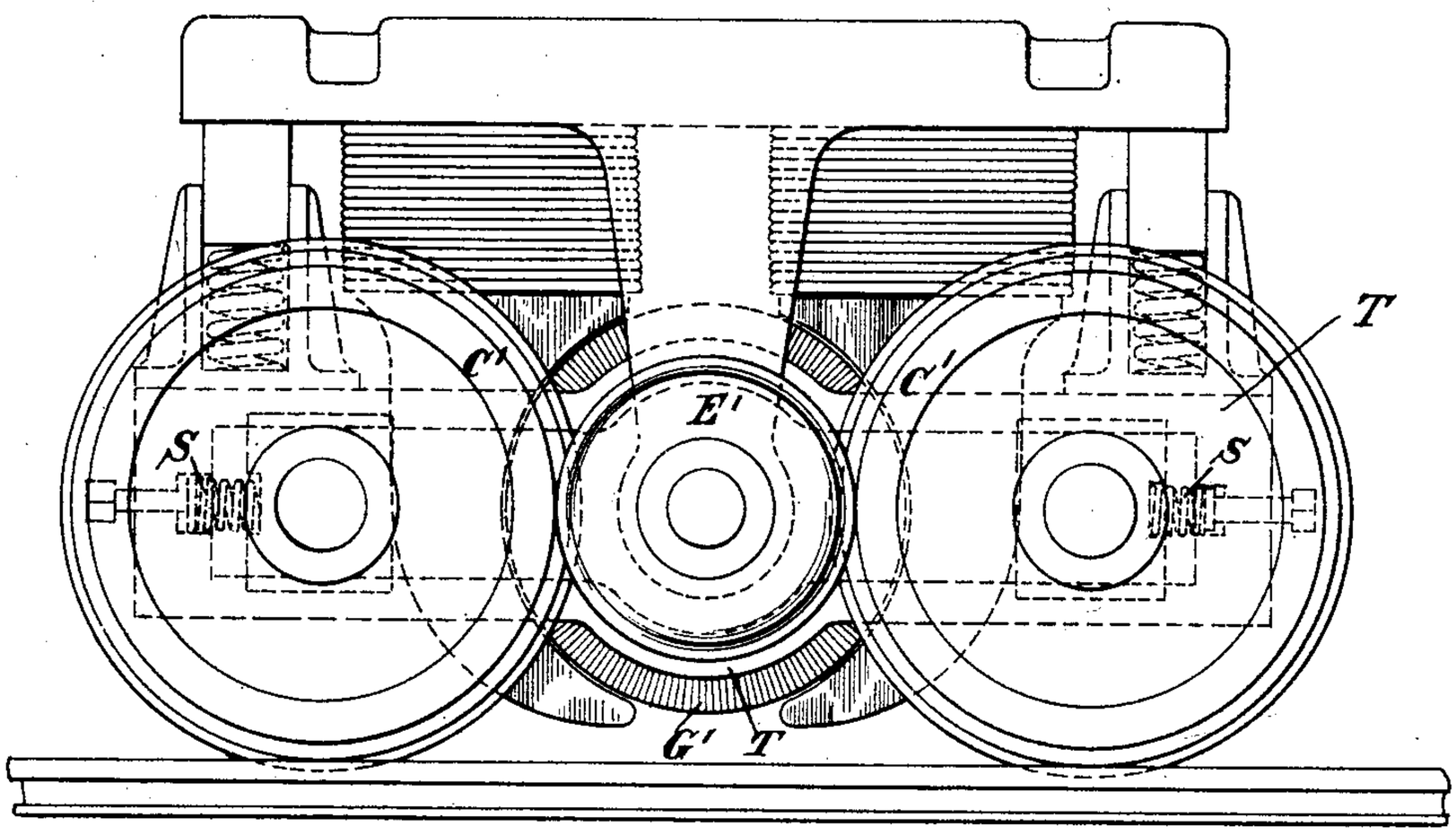


FIG. 5.



WITNESSES:
John Becker
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INVENTOR:
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UNITED STATES PATENT OFFICE.

THOMAS L. WILLSON, OF BROOKLYN, NEW YORK.

ELECTRIC LOCOMOTIVE.

SPECIFICATION forming part of Letters Patent No. 483,822, dated October 4, 1892.

Application filed August 25, 1891. Serial No. 403,701. (No model.)

To all whom it may concern:

Be it known that I, THOMAS L. WILLSON, a citizen of the United States, residing in Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric Locomotives, of which the following is a specification.

This invention relates to locomotives for electric railways, its objects being to facilitate the starting and stopping of the locomotive and to avoid waste of power.

My present invention constitutes in part an improvement upon the construction of electric locomotives embodied in my application for patent, Serial No. 398,382, filed July 3, 1891.

It is well known that locomotives require the most power in starting from a state of rest and that electric locomotives consume the least power at their highest speed by reason of the fact that the electric motor is under such conditions generating the highest counter electro-motive force. The effect of this counter electro-motive force is (with a uniform electro-motive force on the circuit) to reduce proportionately the quantity of current traversing the armature. While at rest the motor generates no counter electro-motive force, so that in order to start the locomotive the current first passed through it encounters only the internal resistance of the motor itself, which ordinarily is very low, so that a current of undue volume traverses the motor, thereby involving the danger of burning out its armature, especially if the latter be made with a winding of wire, as ordinarily constructed. This danger is somewhat reduced in ordinary practice by the use of a resistance-box, so that when a current is first turned onto the armature a resistance is interposed sufficient to shut out from it a current so excessive as to be dangerous. The reduction of the current by such a resistance, however, is objectionable for two reasons—first, that it reduces the power of the motor at a time when the most power is needed in order to overcome the inertia of the load in starting, and, second, because in the hands of the class of workmen who drive electric locomotives there is liability that in manipulating the resistance-box the coils may be cut out of circuit too quickly in order to bring the car rapidly to full speed, thereby in many cases burning out the armature, this danger being especially great when starting on an upgrade. It is also well known in the operation of electromotors for power purposes that if the load be entirely thrown off the motor and its armature permitted to revolve freely it generates a counter electro-motive force very nearly equal to the electro-motive force of the circuit, so that the current traversing it is reduced to only that required to overcome its own friction. It has been suggested in some instances to introduce a friction-clutch in the gearing interposed between the armature-shaft and the driving-wheels of an electric locomotive or car in order that in starting the car the motor may be first started with the clutch disengaged, and upon its attaining full speed, and consequently generating its maximum counter electro-motive force, it can be coupled gradually to the driving-wheels by gradually applying the friction-clutch, thereby starting the locomotive or car without reducing the speed of the motor to below or materially below its normal speed. This method of operating the electromotor presents important theoretical advantages, which, however, have not thus far been realized in practice, so far as I am aware. It is the object of my invention to provide an improved construction and arrangement for this purpose.

According to my invention the armature-shaft of the electromotor is connected by friction-gears or other equivalent gearing to the driving-wheels of the locomotive or car, and the motor-armature is mounted to revolve freely upon the armature-shaft, being connected thereto while at work through the medium of one, or preferably two, friction-clutches engaging the armature on the one hand and the armature-shaft on the other. According to the preferred construction for heavy locomotives, the field-magnet of the electromotor hangs upon the armature-shaft, in order that its weight may be effective to press the friction-gears into tractive engagement. According to another arrangement, the friction-gears on the armature-shaft are embraced between friction-gears in connection with the respective driving-wheels, the latter being forced together by spring or other

pressure and the weight of the field-magnet being supported directly from the framing of the locomotive or through springs or other intermediate supporters. In either arrangement or by whatever system of gearing is employed the armature-shaft is subjected to considerable frictional resistance, even when transmitting only a light load, and to avoid throwing this resistance upon the armature while the locomotive is at rest I construct the armature to turn freely upon the armature-shaft, whereby it turns with the minimum of friction, since being perfectly counterbalanced and subjected to equally-balanced attractive strains it exerts no thrust in any direction likely to generate frictional resistance with the exception of the slight thrust due to upholding its own weight.

Figure 1 of the accompanying drawings is a side elevation of one form of my improved electric locomotive. Fig. 2 is a vertical transverse mid-section thereof on the line 2 2 in Fig. 1. Fig. 3 is a transverse section through the armature and friction clutch on the line 3 3 in Fig. 2. Fig. 4 is a sectional plan showing a modification, and Fig. 5 is a side elevation of the gearing shown in Fig. 4.

Referring to Fig. 1, let A A designate the driving-wheels of an electric locomotive; B B, their axles; C C, the friction-wheels fastened to or connected with them; M, the electromotor; D, its armature-shaft, and E a friction-wheel on said shaft in frictional engagement with the wheels C C, so that by its rotation it drives the latter wheels, and thereby the driving-wheels. The motor M is arranged with its field-magnet F upright, presenting pole-pieces above and below, between which revolves the armature G, as best shown in Fig. 2. The field-magnet or motor-frame F has bearings at *f f*, engaging the armature-shaft D, and the field-magnet frame is hung from these bearings, so that its weight acts to press the shaft D, and thereby its friction-wheels E E, down into firm adhesive contact with the friction-wheels C C of the drivers. The armature G has an iron core *a* and winding *g* of segmental bars separated from one another by insulating-layers, but naked on the outer peripheral face of the commutator, where they are swept by a series or gang of commutator-brushes *b b*, so that the periphery of the armature constitutes the commutator-surfaces. In running backward, brushes *b' b'* (shown in dotted lines) are brought against the commutator in place of the brushes *b b*.

The construction thus far described is that shown in my said application, Serial No. 398,382.

According to my present invention I mount the armature G loosely upon the armature-shaft D, so that it may turn freely thereon, and I provide friction-clutches H H for engaging the armature with the shaft. I will proceed to describe this construction in detail. The armature G is mounted on a hub *c*, provided, preferably, with an inner bushing *c'* of antifriction metal to afford a good bearing-surface against the shaft D. The hub *c* is formed with a cone *d*, extending outwardly from the middle toward one end of the armature. Another like cone *d'* extends to the opposite end and is mounted on the hub through the medium of a key or spline, and screw-bolts *e e* are provided for drawing the cones together. The cones act against an internally-coned sleeve *h*, which is split so as to be capable of expansion. This sleeve is inserted within the armature-winding, and by drawing the cones *d d'* together it is expanded until it forms a strong union therewith, affording such an engagement as to effectually resist any slipping around of the armature-ring on the sleeve or of the sleeve on its cones. An insulating-layer *i* is inserted between the sleeve *h* and the armature-winding. By the construction described the armature-core *a*, winding *g*, hub *c*, cones *d d'*, and sleeve *h* are all locked or bound firmly together and constitute to all intents and purposes one part, which I shall hereinafter designate the "armature." This armature turns freely upon the shaft D, except when coupled thereto by the friction-clutches H H, which in the preferred construction are located within recesses in the hub *c* or in the cones *d d'* thereof. These clutches may be of any suitable construction known to makers of friction-clutches, that shown being a well-known construction in use for many years and known as the "Brown clutch." It is constructed with a hub or carrier *j*, keyed or otherwise firmly fixed to the shaft D. This carrier bears a suitable number of friction-shoes *k k*, two, three, or four in number, as may be found most desirable, three being shown in Fig. 3. Each shoe is formed with a slide *k'*, sliding in a suitable slideway formed in the carrier *j*, whereby the carrier takes the lateral thrust of the shoes. The outer or frictional faces of the shoes, which in practice are ordinarily clothed with a layer of wood or other suitable frictional material, come into direct contact with the inner faces of the cones *d d'* of the armature. To force out the shoes into frictional engagement with the cone, they are forced apart from one another by turning right and left threaded screws *l l*, engaging nuts or internally-threaded blocks *m m*, fitted in sockets in the shoes. These screws are oscillated to expand or contract the shoes by means each of an arm *n*, the several arms being connected by links *p p* to a sliding sleeve *q*, which is movable on the shaft D toward and from the carrier *j*. When moved toward the carrier to the position shown in Fig. 2, the links *p p* throw the arms *n n* to their outermost position, and thereby oscillate the screws *l l* to expand the shoes and thereby cause the clutch to engage the armature. When the sleeve *q* is moved away from the carrier *j*, the links are turned to an angular position, whereby the arms *n n* are moved slightly inward, thereby relaxing the thrust of the screws against the shoes and

contracting the latter sufficiently to disengage the clutch. The sleeve q is operated by a lever I, mounted on a shaft I′, and the lower arms of which constitute a fork, the ends of which are provided with rollers q', which enter a groove in the sleeve q, so that by vibrating the lever the sleeve may be thrown to either position.

To operate the two clutches simultaneously, the levers I of both clutches are connected together, so that the operation of either one will operate the other. To operate them conveniently, I provide hand-wheels J J′ on shafts K K′, respectively, to one of which shafts one of the levers I is connected by an arm L on the shaft, to which is pivoted a link i', engaging the lever, the other shaft being in like manner connected to the opposite lever by an arm L′. The connection between the levers is made by a rod N, pivoted to one lever at one end and at its other end pivoted to an arm L^2, mounted on the shaft K, so that the arms L^2 and L constitute together a reversing-lever for transposing the motion transmitted through the rod N. The operator can, therefore, by turning either hand-wheel throw both clutches simultaneously into or out of engagement.

During the ordinary running of the locomotive the armature is kept coupled by the clutches to the shaft D, thereby continuously revolving this shaft and communicating the rotation through the friction-wheels E E at its ends to the wheels C C of the drivers. When it is desired to stop the locomotive, this may be done by turning off the current or by interposing a resistance in the usual way and by applying the brakes, or it may be done by applying the brakes and disengaging the clutches, thereby freeing the armature from its shaft and permitting it to run of itself at whatever speed it will assume under the current traversing it. The latter method will be the preferable one for short stops. The armature on being disengaged will accelerate in speed until it reaches its typical speed, or that at which the current traversing it is reduced by the counter electro-motive force to only sufficient to overcome the friction of the armature at that speed. Having found this speed, it will continue to revolve at the same speed during the stoppage of the locomotive. To start the locomotive, the engineer will simultaneously throw off the brakes and move the friction-clutches into partial engagement, thereby throwing part of the load or resistance to be overcome upon the armature. The frictional retardation to which the armature is thus subjected will somewhat decrease its speed, while its momentum will be made effective to exert a thrust through the clutches in the direction to start the locomotive. It will then start the locomotive slowly and gently, the speed of the locomotive being gradually increased, while that of the armature is gradually reduced, the slip between the members of the friction-clutch being equal to the difference in speeds, until finally when the locomotive has reached full speed and the armature has been retarded to its normal speed the slip ceases, whereupon the clutches should be applied with full force to couple the armature positively to the shaft. The engineer should apply the clutches at first gently and then with continually-greater force as the speed of the locomotive increases, until when full speed is reached the clutches should be fully applied. If the clutches are applied too rapidly, the armature will have its speed checked too quickly, and its speed will be below the normal by being coupled positively to the shaft before the locomotive has attained full speed, thereby cutting down the electromotive force of the armature to less than the normal, and consequently causing it to be traversed by too heavy a current. In starting on an upgrade or with a heavy load some such diminution of the armature speed below the normal may be necessary in order to cause the armature to exert a greater effective power than under normal running; but in no case should the armature be finally coupled to the shaft until the locomotive has been got under way and brought up to at least a certain percentage of its normal speed, which percentage must be determined by experiment to ascertain the conditions which give the best results.

My invention has the very important advantage that it enables power for overcoming the inertia of the load to be stored up prior to the instant of starting, since the armature constitutes, in fact, a fly-wheel of considerable mass, and which by running free is brought to a high speed, and the power thereby accumulated is then exerted upon the load by a gradual frictional coupling action, which amounts, practically, to turning on the load by degrees.

By my invention the armature is made to revolve freely without carrying with it any gearing or other connecting parts which are subjected to such thrusts or frictional engagement as to occasion any considerable resistance to the free rotation. It has been heretofore proposed to introduce a friction-clutch in the gearing through which the motion of the armature is communicated to the driving-wheels in such manner that when the clutch is disconnected the armature still drives a portion of the gearing interposed between itself and the clutch, and is thereby subjected to the retardation due to the friction of the shafts and gears which it thus entrains. Such a construction would have in practice the disadvantage of throwing considerable work upon the armature, which would reduce the speed thereof in running free to a lower typical speed than that at which it would tend to run, thereby preventing the storing or accumulating of power in the momentum of the armature to as high degree as is possible by means of my invention. Applied to the construction shown in Figs. 1 and 2, for ex-

ample, such a system would involve that the armature by being positively fixed upon its shaft D would drive the latter continually while the locomotive was at rest, thereby encountering the friction of the bearings *f f*, occasioned by the weight of the parts superposed thereon, which would constitute a heavy drag to the armature and prevent its attaining a high enough speed to make its accumulated momentum very effective in restarting the locomotive. In fact, with such a construction the practical advantage of my invention would be lost.

By my invention the use of a resistance-box in starting and stopping the electric locomotive is superseded. I prefer, however, to provide a resistance-box in order to use it for controlling the speed of the locomotive—as, for example, to enable stronger currents to be turned on when ascending a grade.

In the modified construction shown in Fig. 4 the arrangement is such that the friction-wheel E on the armature-shaft (here lettered E′) enters between the friction-wheels on the drivers, (here lettered C′ C′.) In this construction the frictional traction between the friction-wheels is due to the pressure of springs S S acting against the axles of the drivers and forcing them toward one another, so that the friction-wheel E′ is pressed between the wheels C′ C′. The construction is not otherwise altered, except that the field-magnet F′ of the motor is carried by the locomotive-frame T, instead of by hanging on the armature-shaft D′. The construction of armature G′ and friction-clutches H′ H′ is the same as already described with reference to the armature G and clutches H H.

It will be understood that I employ two clutches only for purposes of symmetry and to afford an equal distribution of the strain, it being obvious that the use of one clutch alone would come within my invention.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. In an electric locomotive, the combination, with the armature-shaft of the electromotor and gearing interposed between said shaft and the driving-wheels, of the armature mounted to revolve freely on said shaft, and a friction-clutch adapted to wholly disconnect the armature from its shaft or to gradually couple it thereto, whereby by disengaging the clutch the armature may be caused to revolve without load while the locomotive is stationary, and thereby to store up power by its momentum to be utilized in starting the locomotive by gradually throwing on the load through the medium of said clutch.

2. In an electric locomotive, an electromotor having opposite friction-wheels on its shaft and friction-wheels engaging them in connection with the driving-wheels, the weight of the motor hung from its armature-shaft, whereby it serves to press said wheels into frictional engagement, and the armature thereof mounted to turn freely on said shaft, in combination with a friction-clutch interposed between the armature and its shaft, whereby the armature may be coupled gradually to the shaft.

3. In an electric locomotive, the combination of armature-shaft D, geared to the driving-wheels, armature G, mounted loosely on said shaft and having a recessed hub, and a friction-clutch H, having friction-shoes connected to said shaft and engaging in the recess in said hub.

4. In an electric locomotive, the combination of armature-shaft D and armature G, turning loosely thereon, two friction-clutches H H, engaging said armature to couple it to the shaft, the operating-levers I I for working said clutches, and a mechanical connection between said levers, whereby the operation of either clutch will simultaneously operate the other.

5. In an electric locomotive, the combination of armature-shaft D, armature G, turning loosely thereon and constructed with a hub *c*, having opposite cones *d d′*, and a divided sleeve *h*, expansible thereby within the armature-ring, and friction-clutches H H, having carriers *j* fixed to the shaft, and shoes *k k*, carried by said carriers, said clutches being located in recesses in the ends of the armature-hub and provided with means for expanding said shoes into frictional engagement with the surfaces of said recesses.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

THOMAS L. WILLSON.

Witnesses:
GEORGE H. FRASER,
CHARLES K. FRASER.